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AUTHOR Anderson, Charles; Butts, David
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ABSTRACT

Reported is a study that was partly developmental and partly experimental. A series of worksheets were developed based on the Elementary School Science (ESS) unit, Batteries and Bulbs, and were used to teach three classes of sixth grade students. Two other classes covered the same material using a lecture-discussion technique. Student gains were evaluated through a pretest and posttest and attitudes were evaluated using a sematic differential scale. The net results of the study seemed to show that the students reacted more strongly to the subject matter than to the style in which it was presented. No significant differences were found in either achievement or attitude. Most students indicated a preference for the discussion over the worksheet. The authors believe there is no reason that one method or the other should be chosen for exclusive use and, because sixth grade students can become bored with almost anything if they are forced to keep doing it for too long, it is useful to have two methods available which seem to work about equally well. (Author/EB)

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A COMPARISON OF INDIVIDUALIZED VS GROUP INSTRUCTION IN A SIXTH GRADE ELECTRICITY UNIT

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Charles Anderson
Westlake High School, Austin, Texas

and

David Butts
Department of Science Education
The University of Georgia

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Charles Anderson
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Throughout the United States, school systems are attempting to provide "individualized" instruction for their students. Professionals in education seem to agree that "individualization" is a desirable quality of an educational program. One reason for this wide spread agreement may be that individualization as a concept has almost as many meanings as there are educators. Virtually every science teacher provides individualized instruction in the sense that he attempts to assess the needs of students formally or informally, and "make allowances" for students who are much faster or slower than the main body of the class. Few teachers provide what would be accepted as an individualized instruction by Burns (1971), who says that for instruction to be truly individualized both alternative learning sequences and alternative modes of reforcement must be available.

There may be both advantages and disadvantages to teaching with individualized or self-paced materials. The central question of this study is whether the advantages out weigh the disadvantages.

Do students learn more from individualized or from more traditionally presented materials? Which method of presentation do students prefer? If students are not unanimous in their preference for one treatment or the other, or if learning gains depend upon the characteristics of individual students as well as the method with which the information is presented, a whole new set of questions can then be asked about the characteristics of students who prefer and benefit from one situation rather than another? Do boys, for instance, have different preferences than girls? Do high achievers have different preferences from low achievers? Do boys and girls learn best under different conditions? These are the research questions for which this study was designed to help secure answers.

Related Research

Opinions about individualized instruction and descriptions of how it should be done are available from many sources (Weisberger, 1971; Howes, 1970; Gibbons, 1971). Attempts to evaluate experimentally the effects of individualized instruction are remarkably rare. Much of the experimental literature concerns large computer assisted projects, such as project PLAN or the Individually Prescribed Instruction. This research is not particularly relevant to the needs of teachers who do not have computers available. The evidence to be found in the experimental studies of attempts to individualized without

the help of computers is scanty and more ambiguous than might be expected from the many favorable opinions to be found in print.

In one study, James (1972) compared individualized with group instructional techniques in a seventh grade physical science course. Materials originally developed for the seventh grade course, "Matter," at the University Schools, The University of Iowa, were rewritten as self-paced, programmed materials. Two classes used the programmed materials over a year-long course; a control class was taught by a group-instructional technique. Student attitudes and achievement were evaluated by a variety of pre- and posttests. At the end of the year, there were significant differences between the two groups on one of the three subtests of the Test on Understanding Science. Students in the individualized classes seemed to have a better understanding of the methods and aims of science than those in the group-instructed classes. On seven other tests of achievement and attitude, there were no differences between the two groups, although the students in the individualized group generally appear to score slightly higher.

Gallagher (1970) used materials from the "interaction" unit of the Science Curriculum Improvement Study to teach third graders. Four different treatment groups of 15 students each were instructed in the following manner:

1. Individual audio-tutorials
2. Teacher-taught with group instruction
3. A combination of audio-tutorial and group instruction
4. A control group, not taught at all.

This researcher found no difference among the three groups that

received instruction. The instructed groups did, however, better than the uninstructed group in defining interaction and explaining how they knew when interaction had taken place, but they were not able to identify examples of interaction any better than the control group (uninstructed).

Daugs (1973) reported on the use of multilevel materials in sixth-grade classrooms. SRA's "The Earth's Atmosphere" unit which contains the materials covering similar content at five different levels of reading difficulty, was taught to eight classes of sixth-grade students. The reading level of each student was ascertained by means of an informal reading inventory, and the students were assigned materials written at this level. In seven other classrooms, students used only sixth-grade level materials. No differences between the learning gains scores of the two groups were found, although the control group made slightly higher scores on the post-test. The advantages of having each student working at his own level was apparently cancelled out by the administrative difficulties encountered when five levels of materials were used at the same time.

Kline (1971) studied the attitudes of self-directed and teacher-directed groups of eighth-graders taking the Earth Science Curriculum Project Laboratory Block Program. The students in the program were high ability students taking the program as a supplement to the regular ESCP curriculum. Almost all of the students who participated in the program reported that they liked it, but there were no differences between the attitudes of the two groups.

O'Toole (1970) reported two studies in which students who were

given an individualized instruction program performed better than students given group instruction. In one study, two classes were taught about sound, light, and heat through a teacher-centered approach, and two other classes were taught with programmed materials. Students using the programmed materials performed "individual experiences." Those taught by the teacher-centered approach did not. The two individualized groups were found to have learned more science content than the group taught by the teacher-centered approach. This researcher also found an increase in the teacher's and the student's interest in science. In the second study, O'Toole attempted to determine the effects of individualized approach upon: (1) selected problem solving abilities; (2) science content; (3) science interest; and (4) self-concept. He developed related lessons adapted from Science-A Process Approach. These lessons were for individual student use. One class of fifth-grade students were taught with these individualized materials, and two other classes were taught by teacher-centered approach. Over an instructional period of three months, he found an important increase by the individualized group in their abilities to recognize hypotheses and to recognize problems. There seem to be no change, however, in science interest, science content, or self-concept between the two groups.

Thus past attempts to compare individualized with group instructional techniques seem to produce no clear pattern of results. In most cases no differences have been found between achievement or attitude in groups taught by these two methods.

Attempts to determine experimentally what form programmed or

individualized materials should take present an even more confused picture. Ogunyemi (1972), Koran and Koran (1973), MacDougall (1970), Skinner (1968), Siegel and Raven (1970), Popp and Raven (1972), Hagen (1969), and Vitrogen (1970) are among those who report experimental studies which compared two or more forms of individualized instruction. If any pattern at all emerges from these studies, it is that there is not one form that is most effective for all purposes. The form that individualized instructional materials should take seems to depend upon objectives of the person constructing those materials.

The Study

This study was in part developmental and in part experimental. A series of worksheets were developed by the researcher from the Elementary Science Study unit Batteries and Bulbs. These worksheets were used to teach three classes of sixth grade students at Westlake School, near Austin, Texas. Two other classes covered the same materials using a lecture-discussion technique instead of worksheets. Student gains were evaluated through pretests and posttests, and attitudes were evaluated through using a semantic differential scale.

The sample consisted of 134 sixth-grade students, 53 girls and 82 boys. The students were divided into five classes. Of these, three classes (49 boys and 33 girls) used self-paced worksheets. These students constituted the Worksheet Classes. Two classes (33 boys and 20 girls) were taught using more traditional methods. These students constituted the Discussion Classes. Although some students had changed classes during the course of the year, the classes were

divided roughly along alphabetical lines. They were therefore approximately equal in terms of academic potential. Pretest scores revealed no differences in pretest performance -- that almost all students started with a negligible knowledge of electrical circuits.

Although there were two Chicano students in the sample, all others were Anglo. The socioeconomic of the students varied from working class to upper class, but most came from middle- to upper-middle class families.

The Design of the Worksheets

The Elementary Science Study unit, "Batteries and Bulbs," is a loosely structured unit. Although many problems and activities are suggested, there are no lists of "requirements" or "objectives." It is expected that the students will participate in the activities out of their own natural curiosity about electricity. It is assumed that most will learn as much in the course of their own free exploration as they would through a sequence of activities dictated by the teacher. In this unit the teacher is seen as a guide or as an aide, helping students to find activities that will result in real learning on the student's part.

The worksheets were written with the intent of giving the students an opportunity to try many of the activities suggested in the Elementary Science Study unit, but at the same time putting those activities into a more structured context. For better or worse, is this more structured context characteristic of most elementary classrooms. While students were not forced to limit themselves to only the activities

suggested in the worksheets, they were expected to do at least those activities and to accomplish the objectives listed at the beginning of each worksheet.

Each worksheet consisted of four parts.

1) Objectives: Listed at the beginning of the worksheet primarily for the purpose of telling the student what he is expected to learn from that worksheet;

2) Equipment: Listed at the beginning of the worksheet were those items which the student would need to have in order to accomplish the worksheet;

3) Activities: A series of numbered questions were designed to enable the student to achieve the objectives. The student was expected to answer the questions in his notebook.

4) Test: This was a performance situation designed to see if the student had achieved the objectives.

Procedure

The worksheets were used as the basis for lesson plans for the Discussion classes. Students in the Discussion classes were required to keep notebooks in which they wrote definitions, pictures of circuits they had made, and their answers to circuit problems presented on the chalkboard. They performed experiments similar to the students in the Worksheet groups; they were given similar information; and they were required to answer similar test questions. The basic differences between the Discussion and the Worksheet groups involved the manner in which information was presented and pacing. Students in the Worksheet group were given instructions and information in written form on their worksheets; students in the Discussion group, however, got their instructions and information from the teacher, either orally or on the

chalkboard. Students in the Worksheet section worked at their own pace (although slower ones were under pressure from the teacher); the whole class stayed together in the Discussion sections.

This unit of instruction was taught on a portable building containing two classrooms with no walls between the two classes. The two Discussion classes and two of the three Worksheet classes were team taught. That is, two classes would work on electricity at the same time with two teachers cooperating.

All the equipment was available from a "store" or an equipment table located at the borderline between the two class areas. The equipment table had wire cutters, screwdrivers, pliers, hammers, and other relatively expensive equipment which the students borrowed during the working period. They then returned these before they left the classroom. Less expensive, expendable equipment such as wire, bulbs, bulb holders, and batteries were bought from the store which was run by student "teaching assistants." A student could buy as much as he wanted from the store and could "charge" materials when he did not have money. If the materials were still in good condition when he was finished with them, he could return them to the store and get his money back. In this way it was possible for each student to use as much equipment as he needed, but he would only have to pay for that which he lost, broke up, or used up.

There were two manipulated variables (treatment group and sex) and two responding variables (learning gains and attitude). Learning gains were evaluated by means of a pretest and a posttest. The pretest consisted of 20 questions covering the first two of the nine worksheets.

Since the students were instructed not to guess at answers they did not know, many students answered no questions on the pretest. These students were arbitrarily assigned a score of 42, which is the score predicted by chance on the multiple-choice tests. The average score for all students was 49, only 7 points above the minimum score. There were eight students who demonstrated appreciable knowledge of the material covered in the first two worksheets by scoring 80 or above on the pretest. These students were tested informally on the material in the last seven worksheets. Four of the eight also demonstrated some knowledge of this material.

The posttest consisted of 35 questions. The first 20 were identical with the pretest. The last 15 questions covered Worksheets 3-7, and a bonus question covered Worksheet 8. Each student received two posttest scores. The partial posttest score measured only the student's performance on the 20 questions which were identical with the pretest. The total posttest score measured the student's performance on the entire 36-question test.

Attitude scores were evaluated with a semantic differential scale. Students rated five items (Science, Electricity, My Teacher, Electricity Worksheets, Electricity Class Discussions) on the factors of quality, potency, and activity. The semantic differential was administered the day after the posttest.

Results

The results of this study are presented based on the research questions that were asked. For the first three questions

1) Do students learning gains depend on instructional procedure?

2) Do boys or girls achieve greater learning gains?

3) What interactions exist between treatment group and sex as they affect achievement?

answers were obtained by means of an analysis of variance of treatment groups and sex for posttest scores and analysis of co-variance in which pretest scores were the co-variable and posttest scores were the dependent variable. Inter-correlations were also calculated among the treatment group, sex and achievement.

Relative to the first question, do student learning gains depend on instructional procedure, no differences between the Worksheet and Discussion groups for the pretest, posttest or partial posttest scores were found.

For the second question, do boys or girls achieve greater learning gains, boys scored higher than girls on the pretest ($P < .01$) and the posttest ($P < .05$) and the partial posttest ($P < .01$). An analysis of co-variance indicated that most, though not all, of the difference in the posttest scores were not predicted by the differences in the pretest scores. The differences between the adjusted posttest means for boys and girls approach but did not reach significance. Therefore, it was concluded that boys achieve higher learning gains.

For the third question, what interactions exist between treatment group and sex as they affect achievement, the analysis of variance of posttest scores revealed an interaction effect which

approached but did not reach significance. In the Worksheet group, girls did relatively better and boys did relatively worse than the means for their sex group. Therefore, there was little evidence that there is an interaction between the treatment and the sex as they affect achievement.

For the next three questions

4) Do student attitudes depend upon instructional procedures?

5) Do boys and girls have different attitudes toward the electricity unit?

6) What interactions exist between treatment group and sex, as they affect student attitudes?

answers were obtained by means of an analysis of variance of the sixteen attitude scores from the semantic differential test with treatment group and sex. Correlations were also calculated between sex and treatment group and the sixteen attitude scores.

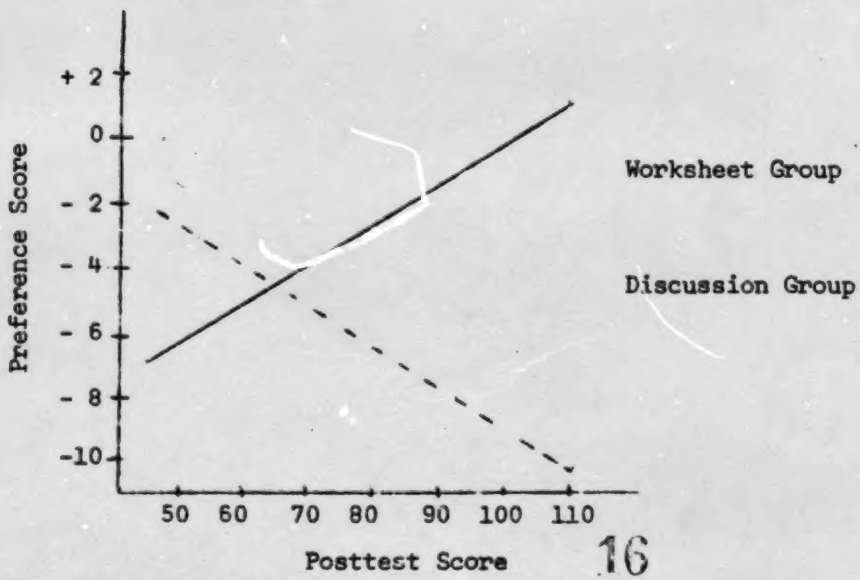
In reference to the question, "Do student attitudes depend upon instructional procedures?", there were no differences in the student's ratings of four of the five items ("Science," "Electricity", "My Teacher","Electricity worksheets","Electricity discussions"). The one exception was "electricity worksheets." The students in the Worksheet group rated worksheets higher on evaluation, potency and activity scales than did the students in the Discussion group. The preference score reveals that both groups indicated a net preference for "discussion" over "worksheets" in both groups. But the preference for class discussions was higher in the Discussion group than in the Worksheet group, therefore the instructional procedure does seem to affect student's attitudes toward worksheets but not toward the unit as a whole.

In reference to the fifth question, "Do boys and girls have difference attitudes toward the electricity unit?", important sex differences appear in every evaluative rating but not in the preference scores. Boys rated "science," "electricity worksheets" and "electricity discussions" higher than girls. Girls rated "My Teacher" significantly higher than the boys. Therefore, boys and girls did have different attitudes toward the unit. Boys liked the unit and the subject matter better. Girls indicated more positive attitudes towards their teacher.

In reference to the sixth question, "What interactions exist between treatment group and sex, as they affect student attitudes?", the analysis of variance revealed no interaction effects.

To answer a seventh question, "How were student achievement and attitude correlated?", intercorrelation matrices were calculated for the three achievement scores and sixteen attitude scores. Separate matrices were calculated for the Worksheet and Discussion groups and the students combined. In the study, students who did well on the posttest gave higher ratings to the unit than students who did poorly. For the Worksheet group high scores on the posttest score correlated highly with positive ratings for "science," "electricity" and "electricity worksheets." For the Discussion group high scores on the posttest correlated highly with positive ratings for "science," "electricity," and "electricity class discussions." Therefore a strong, positive correlation between high achievement and positive attitudes towards "science," "electricity" and the student's method of instruction was found.

A last question, "Do high achievers and low achievers prefer different instructional procedures?", was answered by a preference score being calculated for each student. This was done by subtracting the evaluative score for electricity class discussion from the evaluative score for electricity worksheets. This preference score was correlated with the three achievement scores for the worksheet group, discussion group and the two groups combined. An analysis of co-variance was also conducted in which posttest scores were the co-variable and preference scores were the dependent variable. Overall there were no correlations between achievement on posttests and preference for the worksheet or discussion methods. Within each group, however, there was an important correlation between posttest scores and preference scores. High achievers on the Worksheet group were more positive to worksheets than low achievers. High achievers in the Discussion group were more positive toward discussions. The result of analysis of co-variance of achievement as co-variable and preference score as a dependent variable were given in the graph below.



Only the highest achievers in the Worksheet group indicated a net preference for worksheets over discussions. Therefore, high achievers do not prefer different instructional methods from low achievers.

Conclusions

The net result of this study seems to be the students reacted much more strongly to the subject matter than to the style in which it was presented. There were no differences in either achievement or attitude between students who studied electricity with self-paced worksheets and students who were taught by more conventional class discussion techniques. Most students indicated a preference for discussion over worksheets, but there is reason to believe that some of that preference is an artifact of the opinion sampling procedure. The rejection of worksheets was almost emphatic among students who had never actually used the worksheets. Students in the Worksheet group also like the electricity unit just as much as students in the Discussion group.

Student achievement and interest in electricity thus did not seem to depend at all on the instructional procedure. It did, however, seem to be correlated highly with the characteristics of the individual student, such as sex and interest in science. Boys, for example, did better than girls on posttests and displayed more positive attitudes toward the electricity unit. Student's interest in science was correlated even more highly with posttest scores than with sex. Thus it appears that students react differently to electricity unit primarily

because they were different to start with and not because they were treated differently by the teacher.

There were two important differences between the two instructional procedures from a teachers point of view. To teach this unit by either procedure required a large amount of advanced planning. Assembling sufficient quantities of all the necessary materials is especially difficult and time consuming. However, the problem of writing the worksheets and getting them typed and reproduced makes the worksheet method considerably more demanding in terms of advanced planning time. The worksheet method also seems to present more administrative difficulties in the classroom than does the discussion method. The teachers found that in the self-paced classes they answered the same questions over and over. There were also more problems with students who did not understand the instructions or who became discouraged and wanted to stop working. The discussion classes seemed to make faster progress than the worksheet classes. They finished the unit over a week earlier than most of the students in the Worksheet group.

On the other hand, it can be argued that in the absence of superior achievement on the part of the Discussion students, the worksheet method should be favored because it encourages other desirable student characteristics. For example, students using the self-paced materials had to work independently. They had to understand written explanations and follow written instructions. They

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